

Sirex noctilio

Research Update

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Sirex noctilio



S. noctilio Hosts

- All *Pinus* species
- Stressed pines are preferred
- Pines that produced a large resin flow may be somewhat resistant
- Possibly *Abies*, *Picea*, *Larix* and *Pseudotsuga*
- *Sirex* is a problem where N.A. species of pine are planted.

Research Needs

- Survey Tools
- Control Tools & Strategies
- Regulatory Treatments & Systems
- Impact Assessments
- Basic Biology & Behavior
- Silvicultural

2006 Studies

- Test the feasibility of using trap trees to attract *Sirex noctilio* in North America
- Optimal trap and lure tests
- Mating behavior
- Nematode research
- *Sirex noctilio* impacts
- Regulatory treatments

Tree Girdling Study

Objectives: Determine the sequence of attack by *Sirex* and other insects

Determine the prevalence of attack by *Sirex* on three species of pine

Tree Girdling Study

Variables: Girdling date (May 15, 29 & June 12) – Tree species (Scotch, Red, White)

Experimental Design:

- Three groups of 5 trees for each species/time period were girdled using Banvel (Dicamba) + controls
- One tree in each group was fitted with sticky screen panels (= 6 meters) and all insects captured were collected weekly
- All trees will be evaluated for presence and abundance of *Sirex* and other wood-inhabiting insects

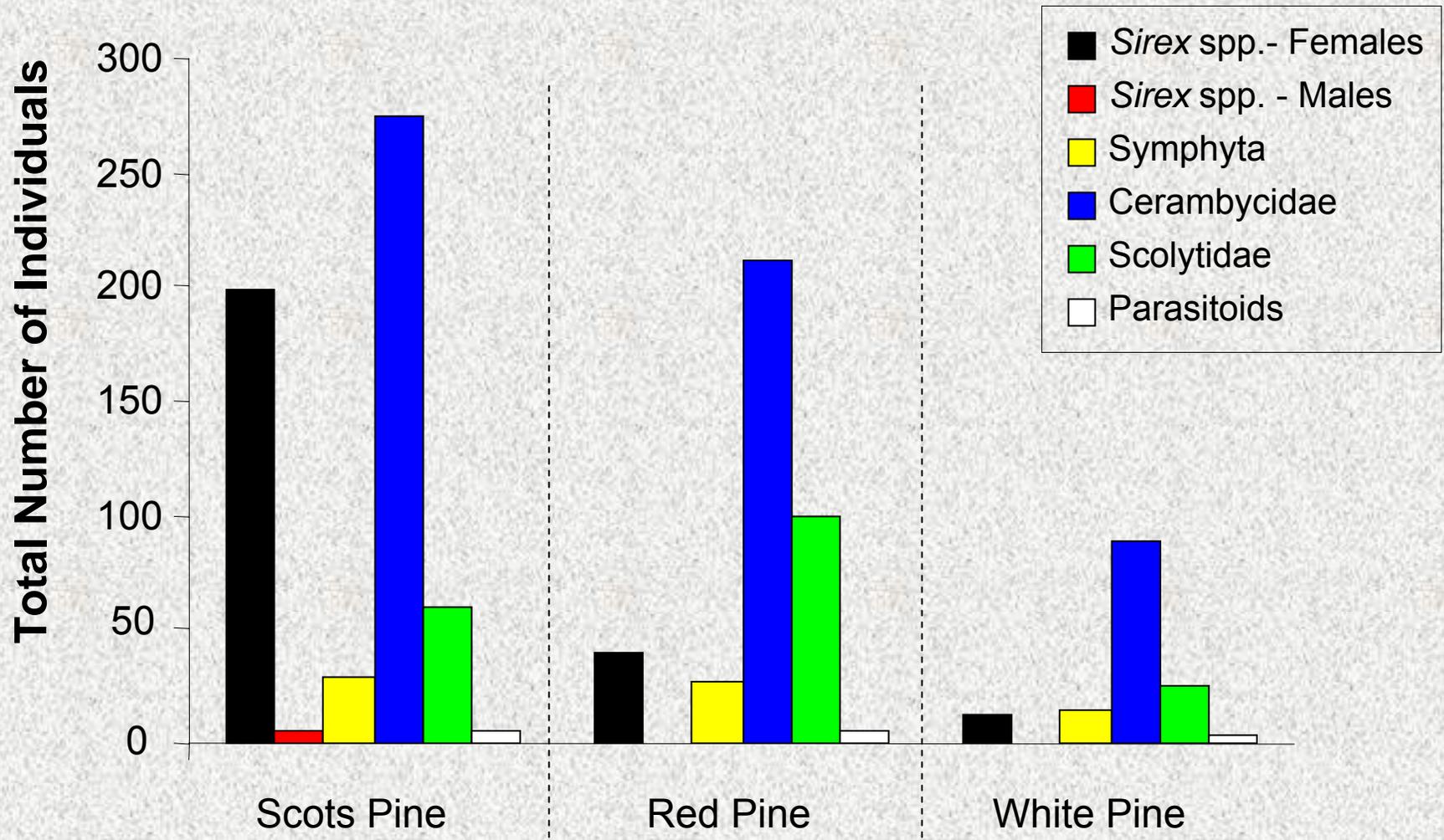
Trap
Tree
with
Sticky
Panels



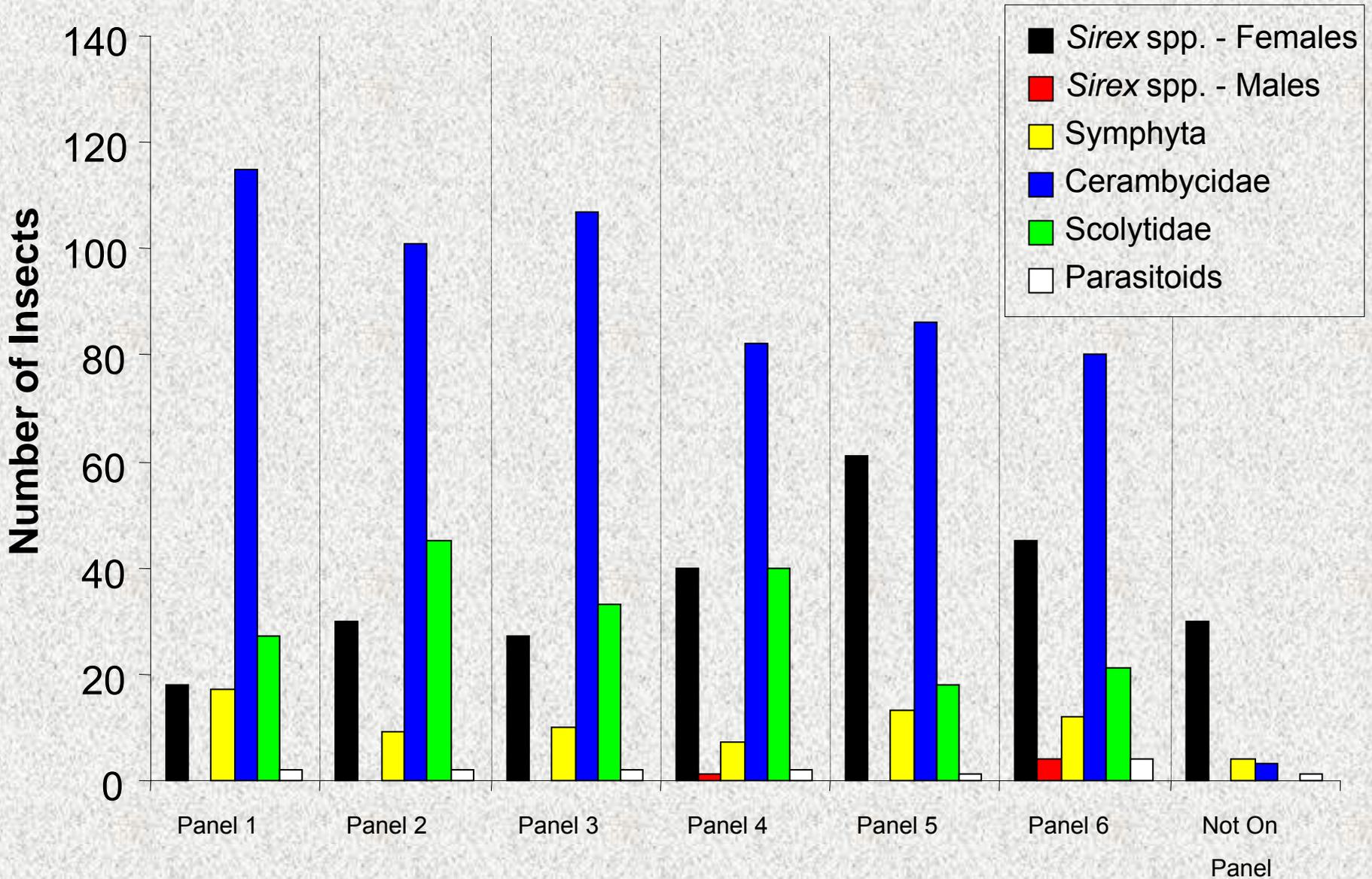
- 98 % of trap trees killed by herbicide injection
- Only 3 trees survived “treatment”
- Red crowns noticeable within 5 weeks of treatment
- Bark beetles and associated insects present soon after treatments



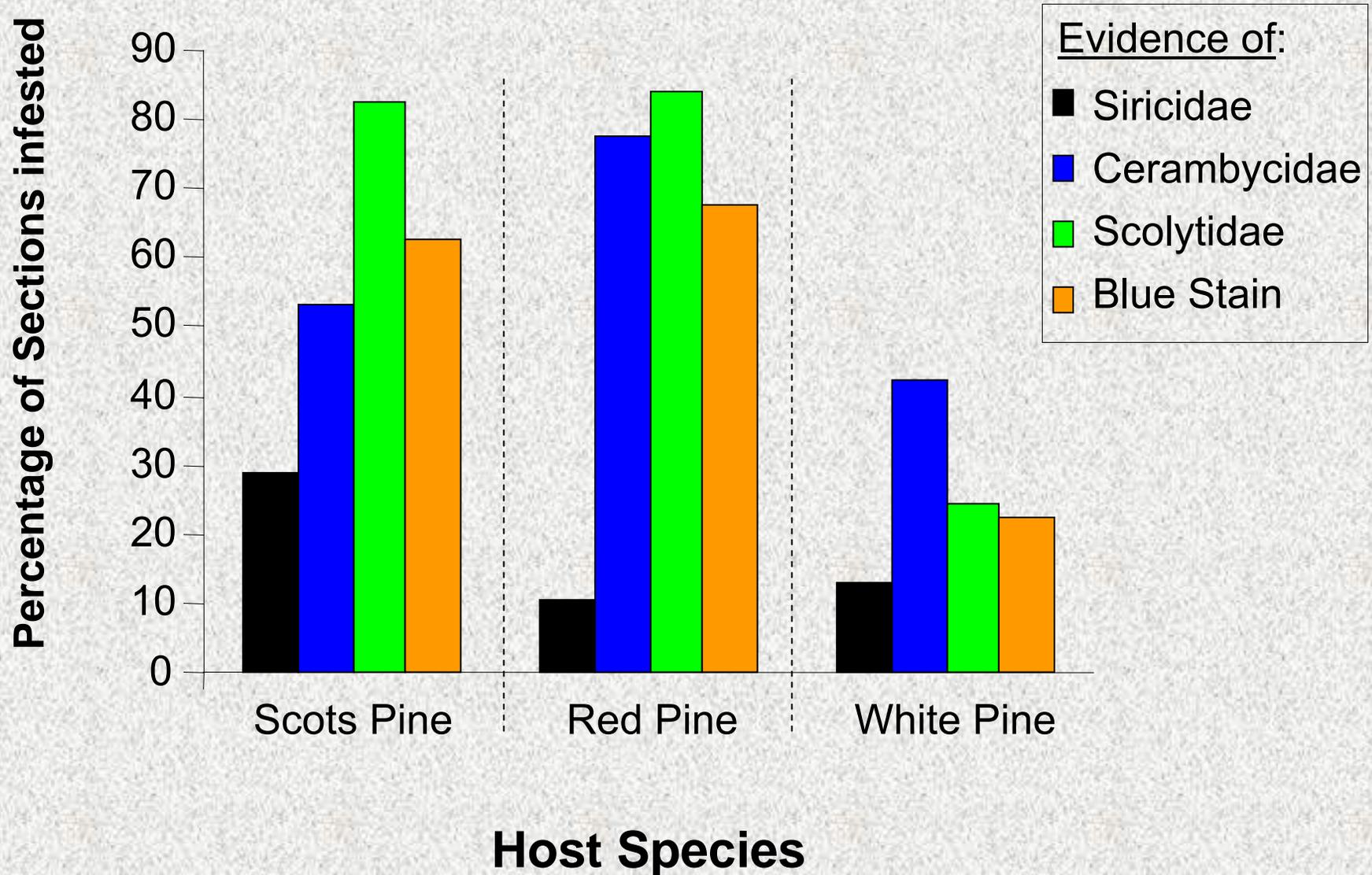
Total Number of Insects Collected on Sticky Panels



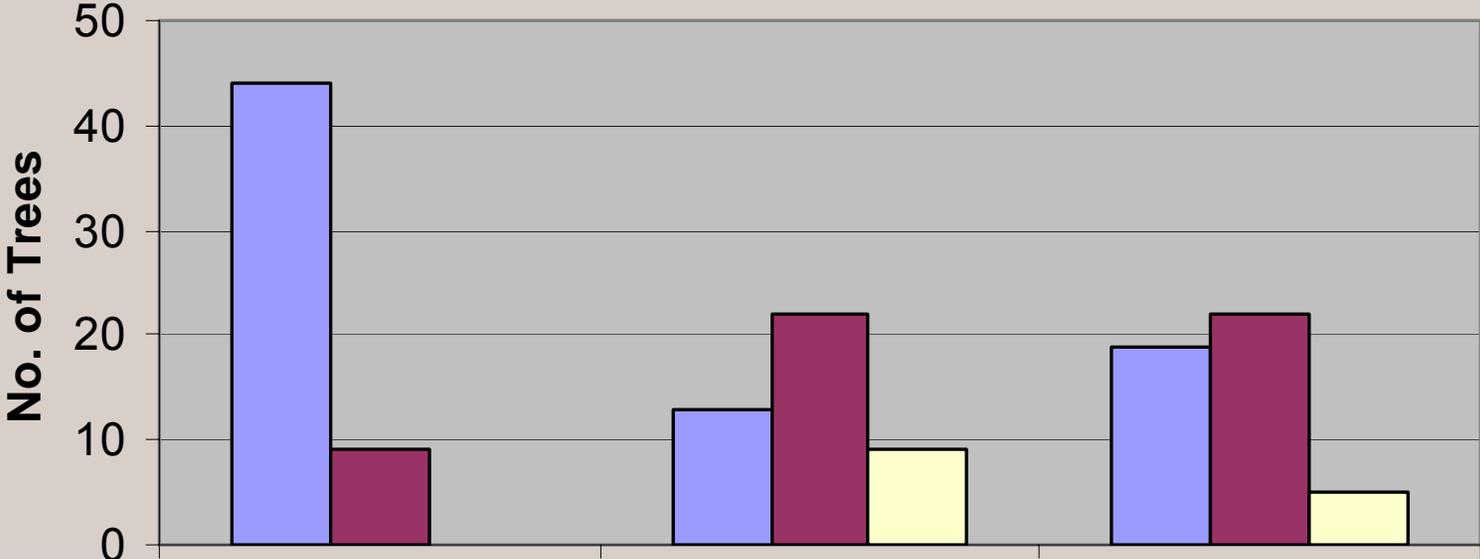
Total Insects Collected Per Panel



Percentage of Infested Sections from Trap Trees



Intensity of Resin Beads - All Trees

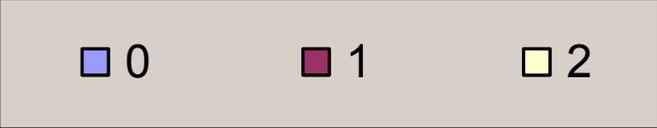


Red

Scots

White

Tree Species





Semiochemical Study

Objectives: Determine the field activity of the semiochemicals identified to-date

Variables: Six treatments and control

Design: Randomized complete block –
7 reps

Other Semiochemical Studies

Determine if host tree volatiles and insect-produced compounds play a role in host and mate finding

Approach: Collection of host tree volatiles from three species of pine (stressed & healthy)

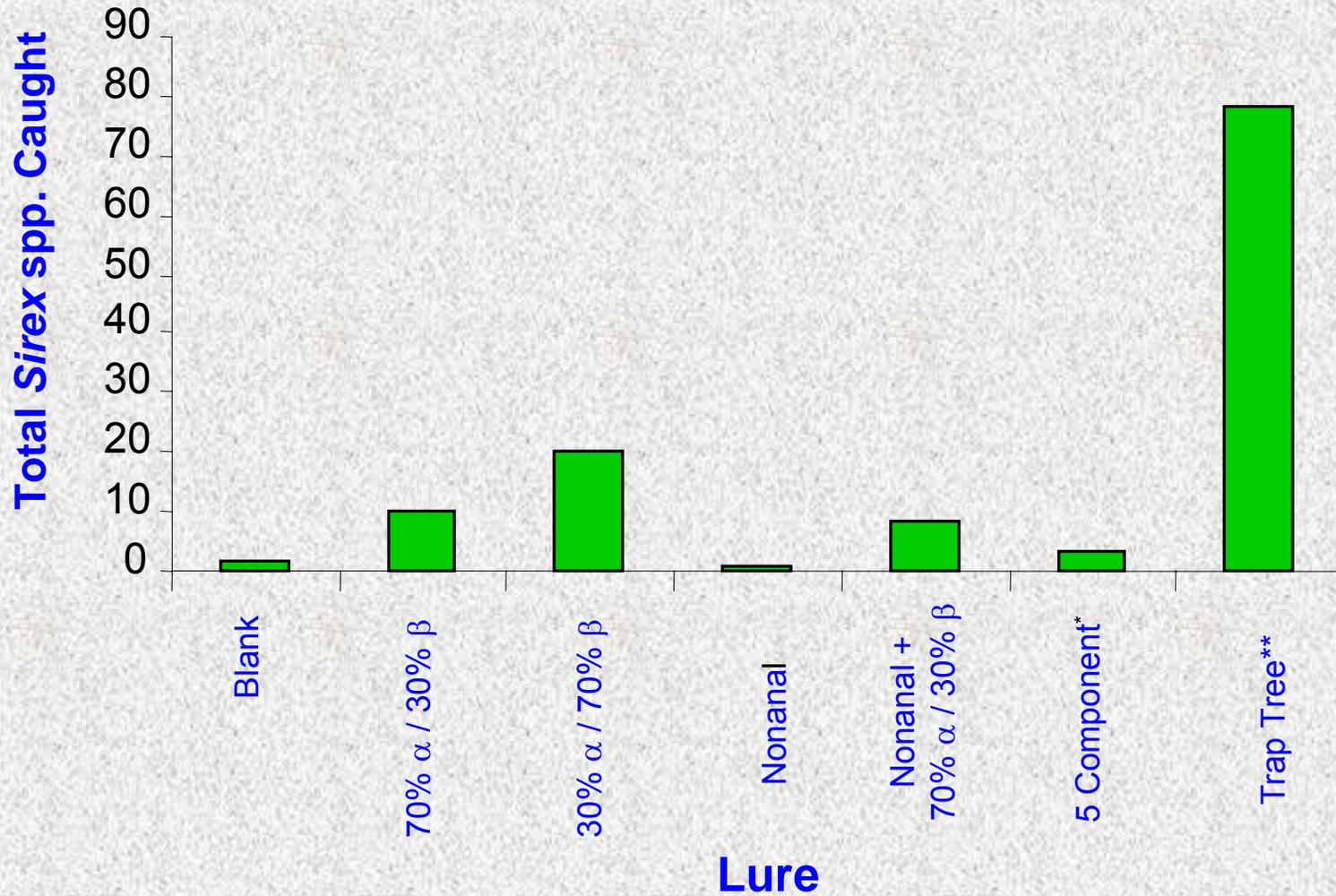
Collection of chemicals from adult *Sirex* and associated fungus

Evaluate activity of chemicals using GC-ED & field and laboratory bioassays

Optimal Lure

- 70% α -pinene, 30% β -pinene
- 30% α -pinene, 70% β -pinene
- Nonanal
- Nonanal + 70% α -pinene, 30% β -pinene
- 5 Component (α -pinene, β -pinene, limonene, myrcene, carene)

Sirex noctilio Semiochemical Study



Lures were tested in conjunction with our crossvane trap

* -- 63% (+)- α -pinene, 30% β -pinene, 3%-limonene, 3 % myrcene, 1% carene

** -- Trap trees were girdled on June 18 and 19

Trap Design Study

Objective: Compare candidate trap designs for *Sirex* capture

Variable: Trap design (Lindgren, Intercept P.T., Crossvane, Trap Log, Drain pipe, & Sante

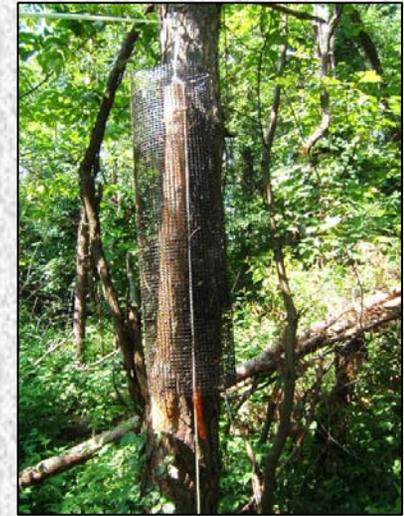
Design: Randomized complete block – 9 reps
*all traps (except log traps) baited with UHR 1/2 sleeve 70:30 alpha:beta pinene



Sante



Crossvane



Log



Intercept Panel

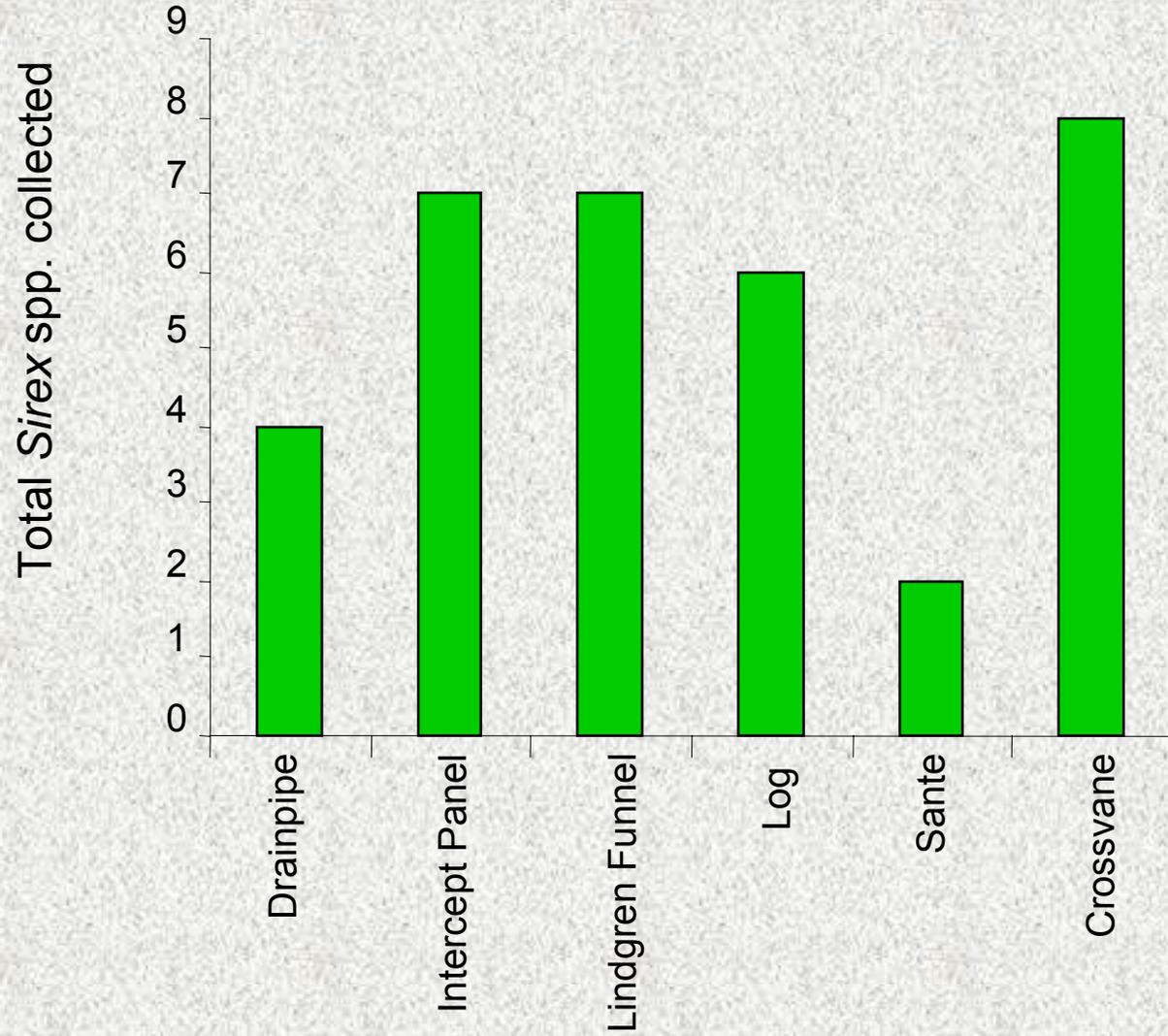


Drainpipe



Lindgren Funnel

Sirex noctilio Trap Design Study



Mating behavior

Antennation



Grasping



Mounting



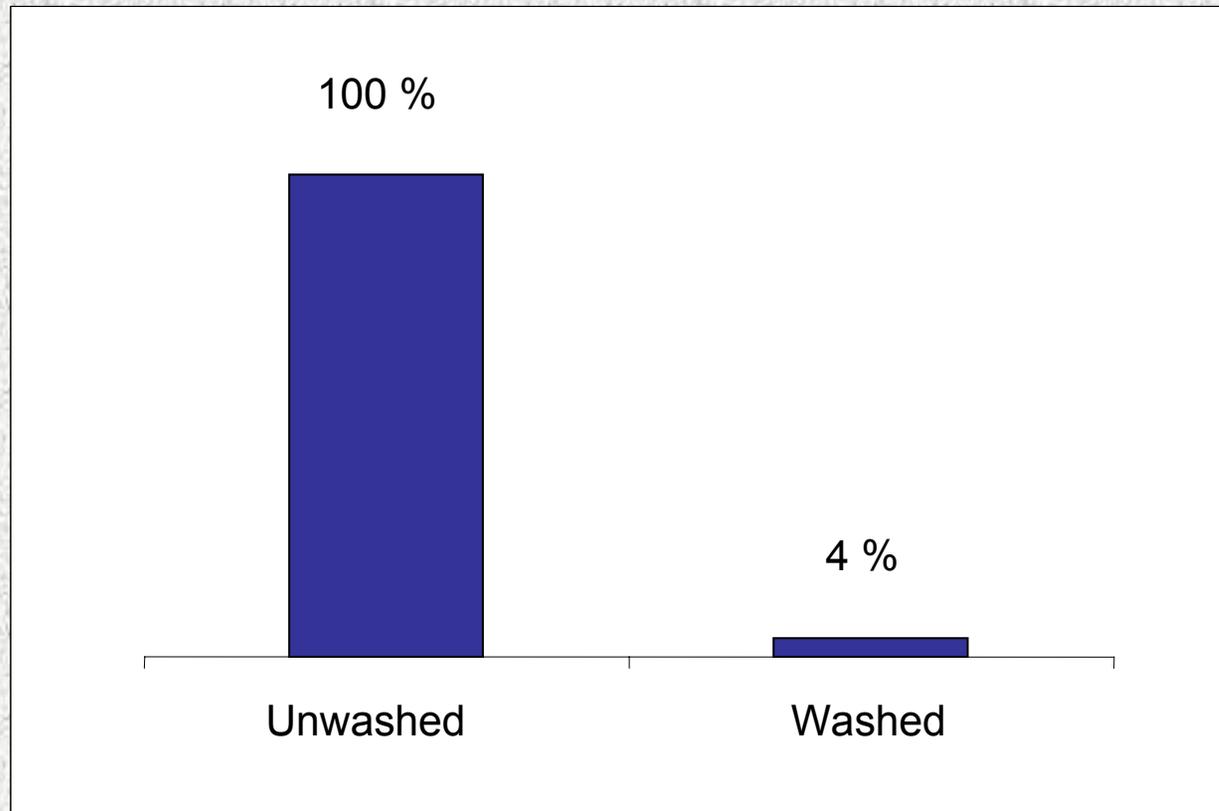
Abdomen bending



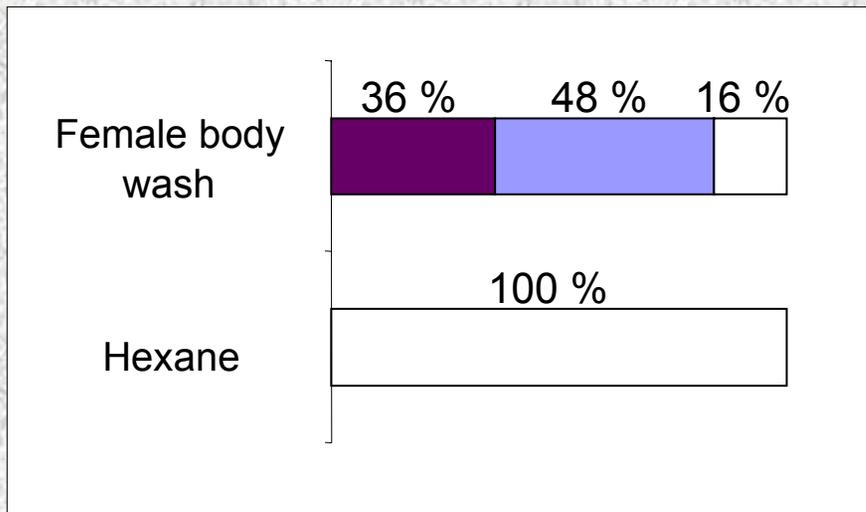
Copulation



**Percentage male response to
Unwashed and hexane washed females
Abdominal bending**



Male response to female cuticular compounds applied to Eppendorf pipettes

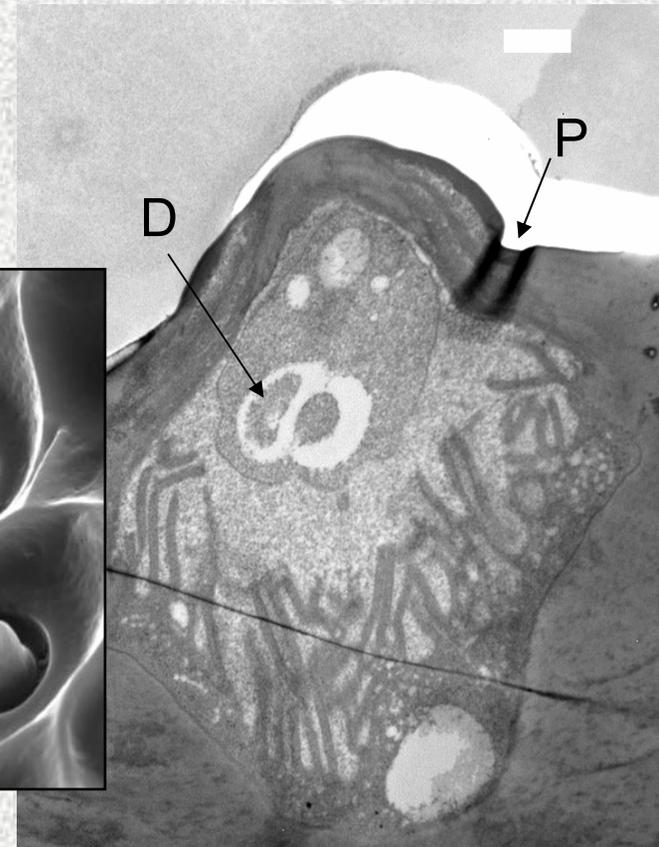
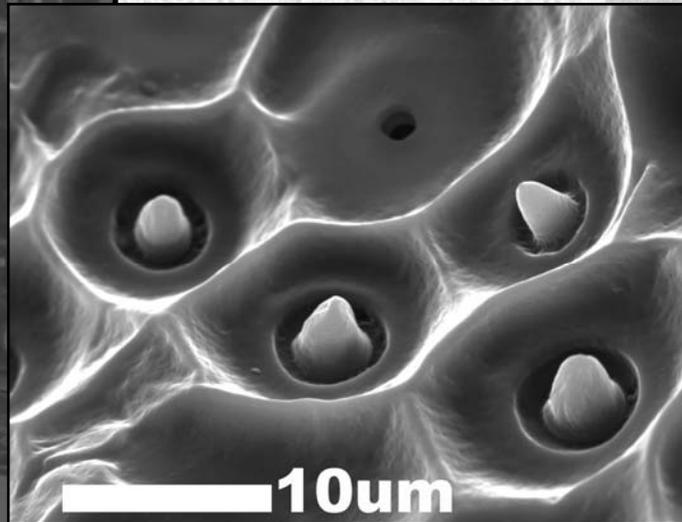
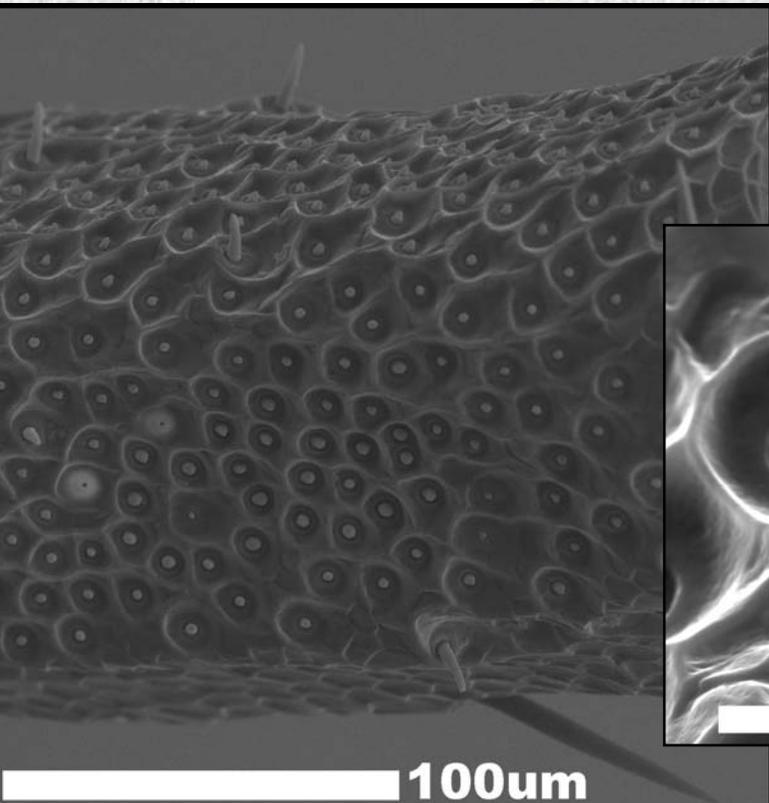


- Abdominal activity
- Stayed on longer than 10 s
- Walked off within 5-6 s or ignored

Antennal morphology



Antennae are covered in small uniporous sensory pegs. Structure is suited to contact chemo-reception.



Semiochemical Work Results

- Found evidence of a contact pheromone
- Developed a bioassay for adults
- Identified a number of antennally active host tree volatiles and insect produced compounds

Conclusions

- Trap trees were effective for attracting *S. noctilio*. Scots pine were attacked more often than other species
- Trap/lure: more tests needed, 1/4 as effective as trap trees
- Log study: logs are attractive to *Sirex*, but only for a short time

Sirex Biological Control Agents

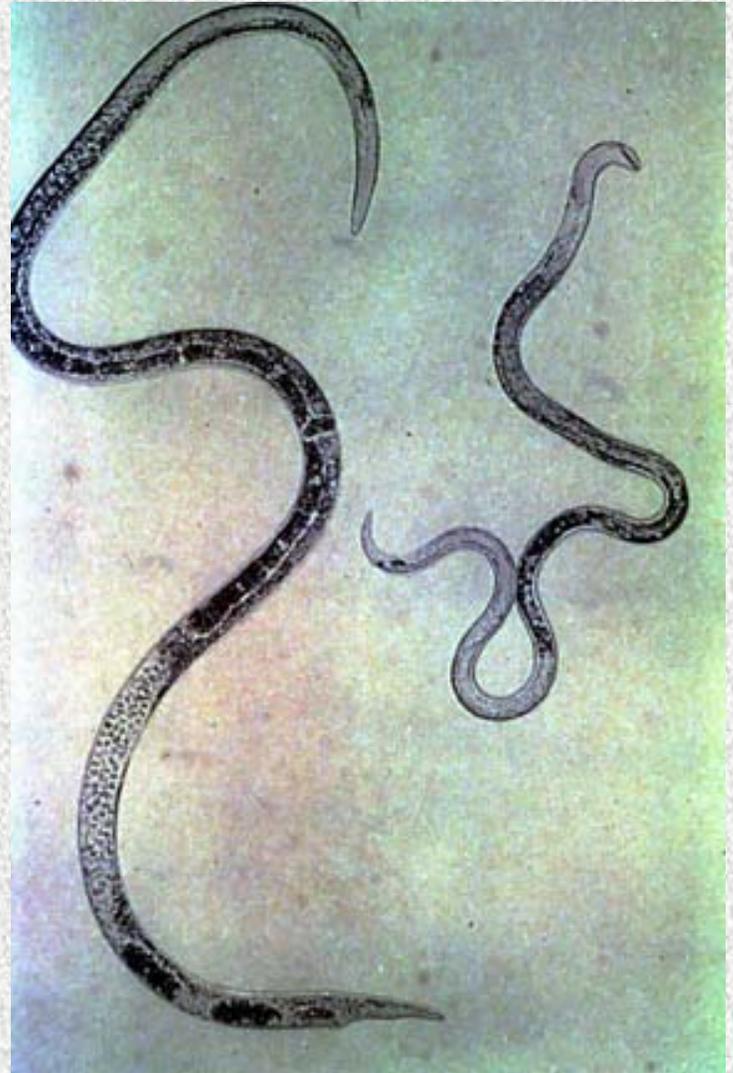


Sirex parasitic nematodes

Beddingia (= *Delandenus*) *siridicola*

Free living form

- Develops in the tree when no *Sirex* larvae present
- Feed on *Sirex* fungus
- Lay eggs which hatch into juvenile free-living form
- Up to 20 – 30 cycles



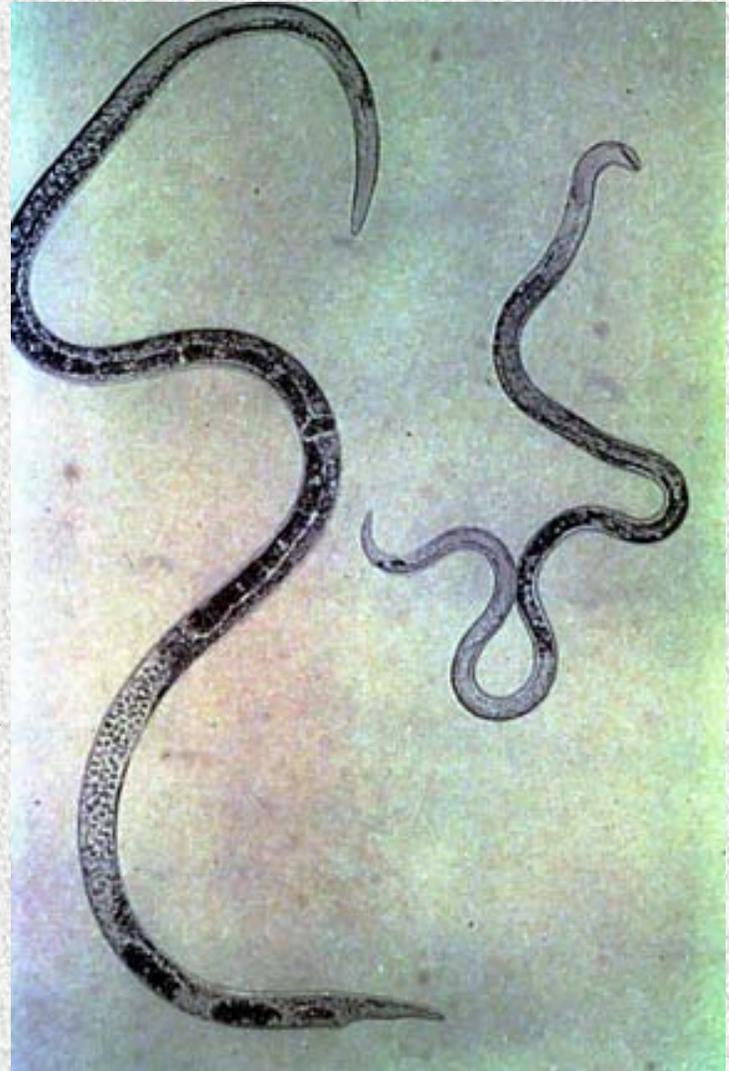
Free-living form (left)

Sirex Parasitic Nematodes

Beddingia (= *Deladenus*) *siridicola*

Parasitic form

- Develops near *Sirex* larvae (high CO₂ levels)
- Infect *Sirex* larvae (adult females)
- Nematodes in the *Sirex* adult migrate from the body cavity into eggs
- Nematodes move back into tree from eggs



Parasitic form (right)

Deladenus (Beddingia) siridicola

- Causes sterility in females. They produce eggs filled with juvenile nematodes
- The nematodes feed on the fungal symbiont (*A. areolatum*) and invade the *Sirex* larvae and pupae.

Controlled release of Sirex nematode – November 2006

Dave Williams – USDA, APHIS
Pest Survey, Detection & Exclusion Lab
Otis ANGB, MA

Biocontrol

Beddingia siricidicola

Objectives: Determine if the “Australian” inoculation method works in North America

Evaluate effectiveness of nematode release in different species of pine trees

Determine spread rates of *B. siricidicola*

Objectives of controlled release

- Test the inoculation technique to see if nematodes could be established in Sirex infested trees
- Assess overwintering survival of Australian nematodes under weather conditions in New York State
- Evaluate infection rate of Sirex emerging from inoculated logs (into closed containers)

Trees inoculated in controlled release

- Trees felled by NYS Department of Environmental Conservation
- 96 trees inoculated
- Three tree species: Scots pine (73), red pine (22), white pine (1)
- Trees chosen for evidence of Sirex attack – primarily presence of resin beads
- All trees were naturally struck and heavily attacked

Nematode application

- Holes punched through bark to sapwood with Australian punch hammer
- 50 holes per tree starting about 1-3 feet from base over length of 25 feet
- Holes spaced 6 inches apart generally in zig-zag pattern along bole



Punching holes



Some difficulties experienced with Ecogrow punches: rapid dulling, jamming with bark, breaking and chipping of cutting edges, rough holes

Nematode application

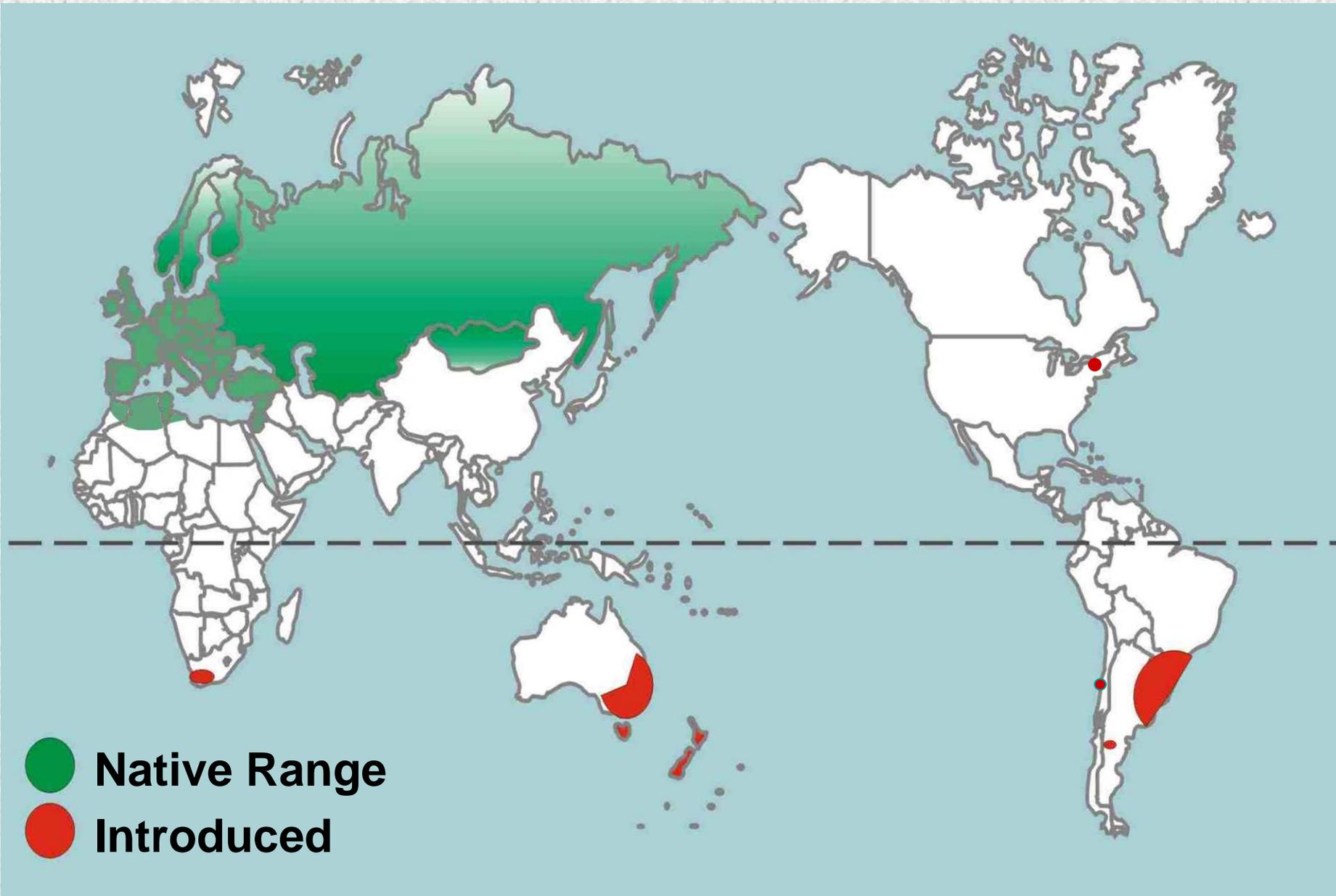
- Inoculum prepared by rinsing nematodes from shipping gel with water and mixing with powdered polyacrylamide gel
- Injected into holes with squeeze bottle and pushed in with fingertip



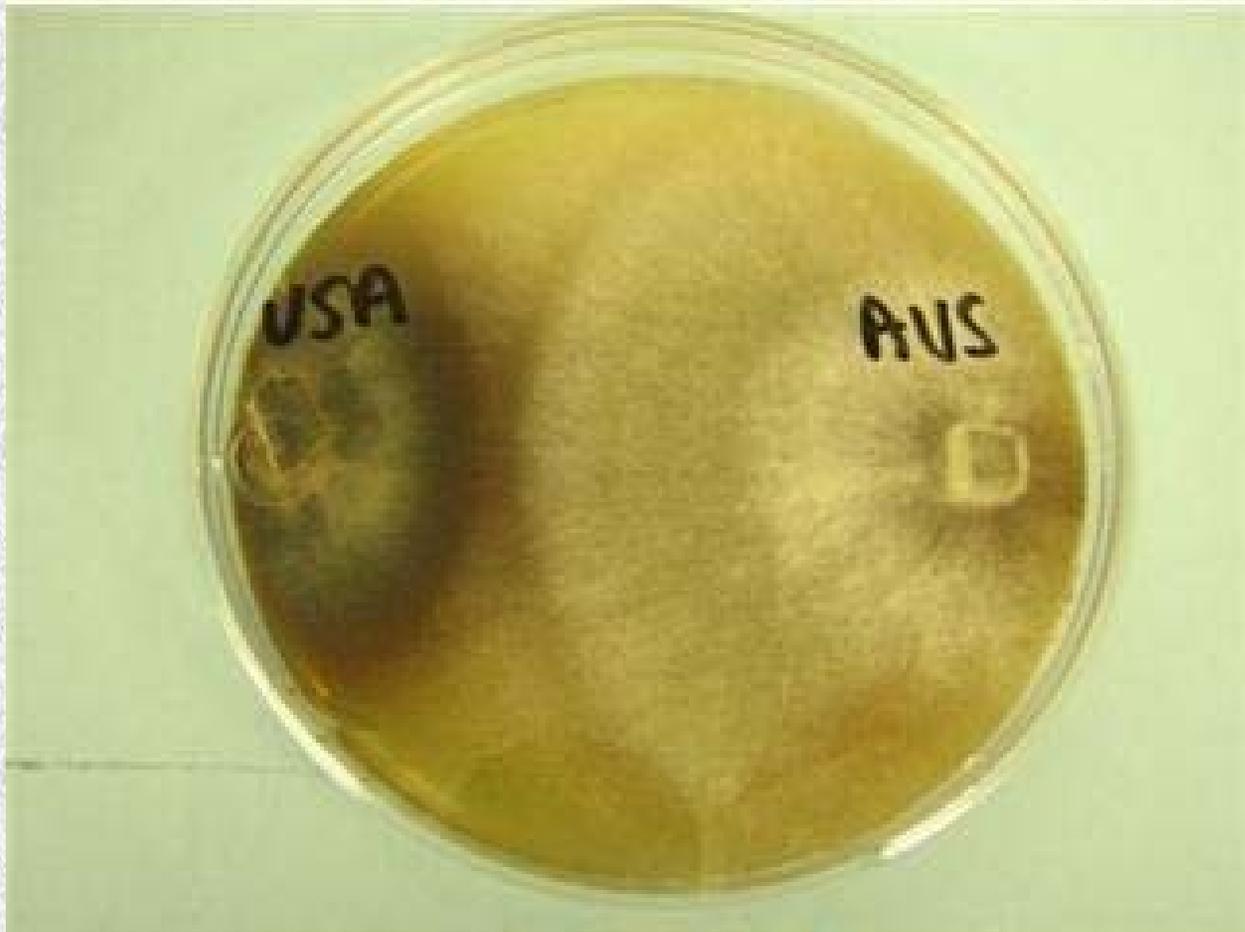
Controlled release or full environmental release?

- Environmental Assessment completed December 2006 and ready for review and comment, permitting full release
- Should *Sirex* nematode be released into the environment in 2007?
- Issue of effects on non-target siricid species
- Issue of releasing fast-growing Australian strain of *Amylostereum areolatum*

Sirex noctilio



Origin of Infestation



Sirex noctilio impacts

- Three stands sampled
- Dendroecological study, Vegetation sampling
- In general, suppressed trees are attacked at much higher rate than codom/dominant trees
- Some codom/dom trees have been attacked – damaged or split leaders
- Sampling will be expanded in 2007

Regulatory Issues



Regulatory Treatment Research

- Fumigation
- Heat treatment
- Pressure treatment
- Mechanical (Chipping & Grinding)
- RF
- Visual Inspection

2007

- Trap trees – operational
- Single tree protection
- Trap/lure
- Impact assessments
- Thinning study (Ft. Drum)

Other Studies

- Adult behavioral observation
- Internal anatomy
- External morphology
- Venom (mucos) gland contents
- Phenology of adult flight
- Characterize the symptoms of *Sirex* attack on different pine species
- Characterize the parasite complex attacking *Sirex* in the U.S.
- Determine the incidence and agent of nematode parasitism already present in US populations

Cooperators

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